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Estimates of Parainfluenza Virus-Associated Hospitalizations and Cost Among Children Aged Less Than 5 Years in the United States, 1998–2010

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Abstract

Background—Parainfluenza virus (PIV) is the second leading cause of hospitalization for respiratory illness in young children in the United States. Infection can result in a full range of respiratory illness, including bronchiolitis, croup, and pneumonia. The recognized human subtypes of PIV are numbered 1–4. This study calculates estimates of PIV-associated hospitalizations among US children younger than 5 years using the latest available data.

Methods—Data from the National Respiratory and Enteric Virus Surveillance System were used to characterize seasonal PIV trends from July 2004 through June 2010. To estimate the number of PIV-associated hospitalizations that occurred annually among US children aged <5 years from 1998 through 2010, respiratory hospitalizations from the Healthcare Cost and Utilization Project Nationwide Inpatient Sample were multiplied by the proportion of acute respiratory infection hospitalizations positive for PIV among young children enrolled in the New Vaccine Surveillance Network. Estimates of hospitalization charges attributable to PIV infection were also calculated.

Results—Parainfluenza virus seasonality follows type-specific seasonal patterns, with PIV-1 circulating in odd-numbered years and PIV-2 and -3 circulating annually. The average annual estimates of PIV-associated bronchiolitis, croup, and pneumonia hospitalizations among children aged <5 years in the United States were 3888 (0.2 hospitalizations per 1000), 8481 per year (0.4 per 1000 children), and 10 186 (0.5 per 1000 children), respectively. Annual charges for PIV-associated bronchiolitis, croup, and pneumonia hospitalizations were approximately \$43 million, \$58 million, and \$158 million, respectively.

Conclusions—The majority of PIV-associated hospitalizations in young children occur among those aged 0 to 2 years. When vaccines for PIV become available, immunization would be most effective if realized within the first year of life.

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Keywords

bronchiolitis; croup; parainfluenza; pneumonia

BACKGROUND

The parainfluenza viruses (PIVs) are enveloped, single-stranded, negative-sense RNA viruses whose human subtypes are numbered 1–4 [1]. After respiratory syncytial virus (RSV), PIV is the leading cause of hospitalization for respiratory illness in young children, accounting for 2%–17% of such cases and, only considering PIV types 1 and 2, 250 000 emergency room visits and 70 000 hospitalizations in the United States [1, 2]. Among children <5 years of age, 1.2 children per 1000 are hospitalized for PIV infection annually. The PIV hospitalization rate is highest among children < 6 months of age (4.6 of 1000 children) [3].

Common symptoms of PIV infection in infants and young children include upper respiratory tract infection, lower respiratory tract infection, croup, pneumonia, and bronchiolitis [4]. Croup is considered “the signature clinical manifestation” of PIV infection, and bronchiolitis and pneumonia are leading causes of hospitalization among infants in the United States [4–6].

Seasonal patterns for PIV types 1–3 are distinct. Outbreaks of PIV-1 typically occur every 2 years, peaking in the autumn. Parainfluenza virus-3 causes spring-summer outbreaks annually. Seasonal patterns of PIV-2 are somewhat erratic, and those for PIV-4 are difficult to define because of the paucity of diagnosed cases from year to year [1].

Most PIV vaccine development has focused on type 3 because it is associated with a substantial number of illnesses and hospitalizations [7]. Questions still abound over whether a stand-alone PIV-3 vaccine is indicated, whether efforts should be focused on developing a combined RSV/ PIV-3 vaccine, or whether work toward a combination vaccine should await proof of principle that an RSV vaccine is even possible [7].

Data are needed to determine which age groups should be targeted for future vaccination efforts based on burden of PIV-associated illness and hospitalization. Counihan et al [8] presented such estimates for the years 1979–1997, relying on data from the National Healthcare Discharge Survey (NHDS) and on proportions of PIV-associated hospitalizations published in studies between 1957 and 1976. Many of those studies used complement fixation and immunofluorescent antigen diagnostic techniques, which are considered less accurate than viral culture and polymerase chain reaction (PCR) techniques that are currently used. The purpose of the present study is to update the data on PIV seasonality and to estimate the annual number of PIV-associated bronchiolitis, croup, or pneumonia hospitalizations among US children <5 years of age during 1998 through 2010 using data that are more robust and recent than those used by Counihan et al [8].

METHODS

Hospital Discharge Data

To estimate the number of bronchiolitis, croup, and pneumonia hospitalizations that occur in the United States annually, data from the Healthcare Cost and Utilization Project (HCUP) Nationwide Inpatient Sample (NIS), a database maintained by the Agency for Healthcare Research and Quality (AHRQ) that contains discharge data from 1056 hospitals representing 45 states, was used. These data approximate a 20% stratified sample of US community hospitals. Included in this database are data on the discharge diagnoses, patient demographics, associated hospital charges, as well as hospital discharge record weights that can be used to calculate nationally representative hospitalization estimates [9]. A subset of hospitalizations among children aged <5 years was pulled for which the first 3 International Classification of Diseases-9th Revision - Clinical Modification (ICD-9-CM) discharge diagnoses codes indicated croup (464.4), bronchiolitis (466.0, 466.1, 490, 491 for children aged 6 to <60 months, which include diagnoses labeled “bronchiolitis” and “bronchitis”), or pneumonia (480–486 for pneumonia diagnoses and, because cases of bronchiolitis and bronchitis among children younger than 6 months are not distinguishable from pneumonia, 466.0, 466.1, 490, 491 for children aged < 6 months, which include diagnoses labeled bronchiolitis or bronchitis, are classified as pneumonia cases for the purposes of this study) that occurred from 1998 to 2010. This subset was further divided into 4 age groups: 0 to 5 months, 6 to 11 months, 12 months to 35 months, and 36 to 59 months. Hospitalizations designated as “less than one year but months of age unknown” were apportioned into the first 2 age groups according to the proportion of hospitalizations among children under 1 year of age for whom age in months was known. Using these data, the numbers of bronchiolitis, croup, and pneumonia hospitalizations that occur in the United States every year were estimated for each of the 4 age groups. In addition, we calculated estimates of mean and total hospitalization charges and lengths of stay. Charges were converted into 2010 US dollars using the US Bureau of Labor Statistic’s Consumer Price Indices from 1998 to 2010 for medical care based on the US city average, not adjusted for season [10].

Population-Based Rates

Population-based rates (hospitalizations per 1000 individuals in the general population) of hospitalizations associated with any etiology and with PIV were calculated using annual US census estimates of children aged <5 years [11–13].

Proportions of PIV-Associated Hospitalizations

Data from the New Vaccine Surveillance Network (NVSN) were used to calculate the proportion of bronchiolitis, croup, and pneumonia hospitalizations associated with PIV-1–4 in children aged <5 years. Admissions from January 2001 to December 2004 in 2 hospitals in Monroe County (Rochester, NY) and 3 hospitals in Davidson County (Nashville, TN) provided data for this analysis as well as admissions from October 2003 to September 2004 in 1 hospital in Hamilton County (Cincinnati, OH) [3, 14]. Each set of hospitals cared for >95% of all hospitalized children that resided in their respective counties [3, 14]. Children enrolled in the NVSN were <5 years of age and had a diagnosis of acute respiratory infection or fever [3, 14]. Specimens from each enrolled child were tested for a variety of

respiratory viruses, including PIV-1–3 for all years using viral culture and reverse transcription-PCR techniques. Parainfluenza virus-4 was also tested for but only sporadically [3, 14]. In addition, data on age and ICD-9-CM discharge diagnoses were collected for each child [3, 14]. Bronchiolitis, croup, and pneumonia hospitalizations were defined as described above for the HCUP data. The proportion of hospitalizations associated with PIV was calculated using NVSN data by dividing the number of hospitalizations with positive PIV laboratory results by the total number of hospitalizations for each syndrome. Average annual proportions were stratified by PIV subtype and age group.

To estimate the number of hospitalizations associated with PIV infection in the US every year, the national estimates of bronchiolitis, croup, and pneumonia hospitalizations calculated using HCUP data were multiplied by the proportions of these syndromes associated with PIV infection as determined using NVSN data. The numbers of annual PIV-associated hospitalizations were described by syndrome, virus subtype, and age group.

Seasonality Data

Data from the National Respiratory and Enteric Virus Surveillance System (NREVSS) [15], a passive laboratory surveillance system, were used to characterize seasonal PIV trends from July 2004 through June 2010. Reporting seasons in NREVSS run from July to June of the following calendar year. Weekly totals of PIV tests performed by antigen detection, which was the most consistently reported test type, as well as the number of positive tests by type (PIV1–4 and unknown PIV) were used to calculate national positive percentages for each type. Information on ordering practices for laboratory tests was not collected.

RESULTS

Bronchiolitis

From 1998 to 2010, the average annual estimate of bronchiolitis hospitalizations among US children <5 years of age was 74 315, occurring at a rate of 3.1 per 1000 children. The highest hospitalization rate was among 6- to 11-month-old children (15.3 hospitalizations per 1000 children) (Table 1). Based on NVSN data, 3.2% of bronchiolitis hospitalizations among children <5 years of age were associated with PIV, with the highest percentage being among children 1–2 years old (6.8%). No bronchiolitis hospitalizations were found to be associated with PIV among children 3–4 years old. By applying the PIV proportions to the bronchiolitis hospitalization estimates by age, we estimated that, nationally, there were 3888 PIV-associated hospitalizations annually (0.2 hospitalizations per 1000), over two thirds of which occurred in children 1–2 years of age (67.9%). Most hospitalizations were associated with PIV-3 (Table 2).

Croup

Croup was associated with an annual average of 18 289 hospitalizations (0.9 hospitalizations per 1000 children) among children aged <5 years during 1998 to 2010. Over half (55.3%) of these cases occurred in patients 1–2 years old (Table 1). Among NVSN children that were hospitalized for croup, 46.6% of those hospitalizations were associated with at least 1 type of PIV, and PIV-1 was the most frequent (26.3%) among the subtypes. Parainfluenza virus

infection was associated with 53.0% of croup hospitalizations among 1- to 2-year-olds. The total estimate of PIV-associated croup hospitalizations nationwide was 8481 per year (0.4 per 1000 children), 63.2% of which occurred among 1- to 2-year-olds. Parainfluenza virus-1 accounted for the majority of PIV-associated croup hospitalizations in all age groups (Table 2).

Pneumonia

An estimated average of 232 774 pneumonia-related hospitalizations (11.8 hospitalizations per 1000 children) occurred each year from 1998 to 2010 among children aged <5 years. The age group most affected was 0–5 month olds, who accounted for 50.8% of hospitalizations (Table 1). Among NVSN children, PIV infection was associated with 5.5% of pneumonia hospitalizations in children less than 5 years, with PIV-3 accounting for the largest share (2.8% of pneumonia hospitalizations) among the subtypes. The 6- to 11-month-old age group had the highest proportion of PIV-associated pneumonia hospitalizations (8.2%). An estimated 10 186 pneumonia hospitalizations (0.5 per 1000 children) were associated with PIV infection each year, over half of which were associated with PIV-3 (54.4%) (Table 2).

Seasonality

National Respiratory and Enteric Virus Surveillance System data from July 2004 through June 2010 included 709 004 antigen tests for PIV from 218 laboratories and show that circulation generally follows type-specific seasonal patterns (Figure 1). Parainfluenza virus-1 followed a biennial pattern with circulation beginning to rise between May and July, peaking in September or October, and decreasing between December and January of odd-numbered years. The percentage of positive tests peaked between 1.4% and 5.1%. In comparison, PIV-3 circulated every year, with proportions of detections rising in March and peaking between April and July. The peak percentage of positive PIV-3 tests ranged from 3.6% to 7.0%. Circulation of PIV-2 was less defined than PIV-1 or -3, but activity was greatest between August and January, with percent positive peaks that ranged from 0.2% to 1.1% and occurring between September and November during the study period. Parainfluenza virus-4 was not reported frequently enough to discern a definite seasonal pattern of circulation.

In NVSN, the proportion of bronchiolitis, croup, and pneumonia hospitalizations associated with PIV was higher in odd years than in even years. This trend remained true for the individual PIV subtypes with some notable exceptions. A larger proportion of croup and pneumonia hospitalizations associated with PIV-3 occurred in even years than in odd. A similar observation was made for PIV-2-associated croup hospitalizations (Table 2).

Hospital Charges and Lengths of Stay

From 1998 to 2010, we estimated that charges for PIV-associated bronchiolitis hospitalizations were over \$42 million annually. During the same time period, PIV-associated croup hospitalization charges exceeded \$57 million. Parainfluenza virus-associated pneumonia hospitalization charges approached \$158 million during the study period. Total hospital days for PIV-associated bronchiolitis, croup, and pneumonia

hospitalizations in the United States were estimated to be approximately 11 000, 15 000, and 36 000 days per year, respectively (Table 3).

CONCLUSIONS

The current study presents the latest available estimates of the burden of PIV-associated hospitalizations in the United States. These estimates were very close to those of Weinberg et al [14] but tended to fall within the lower half of the ranges of estimates published by Counihan et al [8]. The latter trend is due in part to the tendency of the PIV-associated proportions used in the present study to generally fall near the minimum of the ranges of the proportions reported by Counihan et al [8], adjusted for syndrome and subtype.

The ranges of proportions used by Counihan et al [8] were derived from 6 prior studies conducted between 1957 and 1976 that varied widely in location, age of the study population, and testing methods. In contrast, those used by the current study were drawn from NVSN, which was conducted among 3 US county populations from 2001 to 2004 using viral culture and PCR diagnostic techniques and was restricted to children <5 years of age. Because of the improved accuracy of viral culture and PCR techniques over complement fixation and immunofluorescent antigen tests, which contributed in part to the Counihan et al [8] estimates, as well as the better comparability between the NVSN and HCUP populations in location and age, the proportions derived from NVSN seem better suited for use in calculating estimates of recent PIV-associated hospitalizations nationwide than those currently available in the literature. Furthermore, the ranges in proportions of hospitalizations attributable to PIV in the current literature generally do not account for age. Stratifying by age group in the NVSN proportions reveals substantial variation. For example, the proportion of croup hospitalizations associated with PIV-1 in NVSN ranges widely, from 14.3% in 6- to 11-month-olds to 37.5% in 3- to 4-year-olds, although it should be noted that the small number of croup hospitalizations in NVSN in the latter age group may have contributed to an overestimation of cases. Overall, the associations between the individual PIV subtypes and hospitalizations vary not only by syndrome but also by age group. Failure to account for differences in the proportions of PIV-associated syndromes across age groups may contribute to inaccurate estimates of PIV-associated illnesses. Finally, the HCUP, whose data were used in the present study, had a larger sample size than the NHDS, used by Counihan et al [8] (1056 vs 239 hospitals, respectively [16]) and contained data on hospital charges, which are absent in the latter.

The seasonal trends in the circulation of PIV-1–3 between July 2004 and June 2010 reported in the present study are like those reported by Fry et al [2] from July 1990 to June 2004 also using NREVSS data. This finding suggests that there has been no substantial change in the biennial PIV-1 and annual PIV-2 and -3 patterns since at least 1990.

The present study has some limitations. First, although NVSN captured a large number of acute respiratory infection patients from 2001 to 2004 ($n = 3015$), when stratified by age group the numbers of patients diagnosed with bronchiolitis or croup became small among children aged 3–4 years ($n = 12$ and $n = 8$, respectively). Therefore, the proportion of those syndromes associated with PIV may be unreliable in that age group. Second, although the

present study reports the proportion of PIV-associated hospitalizations for each syndrome, it is not possible to precisely determine the causative role of the virus, especially in the presence of positive test results for other pathogens. Although there is 1 PIV-specific ICD-9-CM code, “pneumonia due to parainfluenza virus” (480.2), it was rarely used in HCUP. For this reason, the number of hospitalizations caused by PIV may be less than the estimates reported here. Third, estimates for PIV-4 could not be made because testing in NVSN for that subtype took place inconsistently. Fourth, estimated hospital charges were available in HCUP NIS and are presented here. They reflect the amount billed by the hospital and do not include physician fees; in general, charges are higher than the cost of care [17]. Costs could not be estimated because cost-to-charge ratios were not available for all years under study. Lastly, the estimates of PIV-associated hospitalizations presented here are derived from 2 study populations, HCUP NIS and NVSN, that represent different time periods and geographic areas. Although the comparability between these populations is closer than that between the contributory data sources of comparable studies, the differences may introduce biases to the final estimates, especially if the proportions of PIV-associated hospitalization in NVSN differ substantially from those of the general population.

The results of the present study indicate that the bulk of PIV-associated hospitalizations among children aged <5 years occurs from ages 0 to 2 years, with a marked increase among 1- to 2-year-olds. This finding suggests that immunization would be most effective in preventing hospitalizations if the vaccine were administered early in the first year of life. Furthermore, although some vaccine candidates currently in development are directed at PIV-3 alone or in combination with RSV [18–21], the results of the current study show that, combined, PIV-1-associated bronchiolitis, croup, and pneumonia hospitalizations occur slightly more frequently than PIV-3-associated hospitalizations, indicating that efforts to develop a PIV-1-containing vaccine should also be considered.

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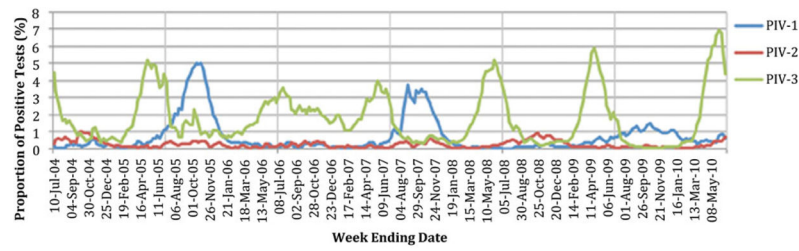


Figure 1.
Percentage of antigen tests positive for **parainfluenza virus** (PIV)-1–3 by 3-week running average from July 2004 to June 2010 reported to the National Respiratory and Enteric Virus Surveillance System.

Table 1

Estimates of Annual Bronchiolitis, Croup, and Pneumonia Hospitalizations, Hospitalization Rates, and Number Specimens Tested for Parainfluenza Virus, by Syndrome and Age Group for All, Even, and Odd Years From 1998 to 2010 in the United States

Age Category	All/Even/Odd Years		
	Number of Hospitalizations*	Population Rate per 1000 [†]	Specimens Tested [‡]
Bronchiolitis			
0–5 mo	–	–	–
6–11 mo	30 403/29 768/31 144	15.3/15.0/15.6	170/87/83
1–2 yr	38 841/37 660/40 219	4.9/4.8/5.1	118/55/63
3–4 yr	5071/4971/5188	0.6/0.6/0.7	12/4/8
Total 0–4 yr	74 315/72 399/76 550	3.8/3.7/3.9	–
Croup			
0–5 mo	3173/2811/3596	1.6/1.4/1.8	16/7/9
6–11 mo	3102/2560/3735	1.6/1.3/1.9	28/12/16
1–2 yr	10 105/7776/12 823	1.3/1.0/1.6	66/27/39
3–4 yr	1908/1542/2335	0.2/0.2/0.3	8/5/3
Total 0–4 yr	18 289/14 689/22 488	0.9/0.7/1.1	–
Pneumonia			
0–5 mo	118 245/90 402/92 836	59.5/45.7/46.5	613/298/315
6–11 mo	20 354/19 817/20 981	10.2/10.0/10.5	97/52/45
1–2 yr	67 352/65 215/69 844	8.6/8.3/8.9	274/153/121
3–4 yr	26 824/25 949/27 845	3.4/3.3/3.5	118/64/54
Total 0–4 yr	232 774/201 383/211 506	11.8/10.2/10.7	–

Abbreviations: HCUP, Healthcare Cost and Utilization Project; NIS, Nationwide Inpatient Sample; NVSN, New Vaccine Surveillance Network.

* National estimate of hospitalizations from HCUP NIS.

[†] Hospitalizations per 1000 US children.

[‡] Number of specimens tested in NVSN.

Percentage of PIV-Associated Hospitalizations, Estimated Number of Hospitalizations, Population-Based Rates, by Syndrome, Age Group, and PIV Subtype for All, Even, and Odd Years From 1998 to 2010 in the United States

Table 2

All/Even/Odd Years											
Bronchiolitis				Group				Pneumonia			
Age Category	Subtype	Percentage of Hospitalizations (%) [*]	Number of Hospitalizations [†]	Hospitalizations per 1000 Children [‡]	Percentage of Hospitalizations (%) [*]	Number of Hospitalizations [†]	Hospitalizations per 1000 Children [‡]	Percentage of Hospitalizations [*] (%)	Number of Hospitalizations [†]	Hospitalizations per 1000 Children [‡]	Hospitalizations per 1000 Children [‡]
0–5 mo	PIV-1	–	–	–	18.8/0.0/33.3	597/0/1197	0.3/0.0/0.6	0.7/0.3/1.0	828/271/928	0.4/0.1/0.5	
	PIV-2	–	–	–	18.8/28.6/11.1	597/804/399	0.3/0.4/0.2	0.2/0.0/0.3	236/0/279	0.1/0.0/0.1	
	PIV-3	–	–	–	0.0/0.0/0.0	0/0/0	0.0/0.0/0.0	2.1/1.7/2.5	2483/1537/2321	1.2/0.8/1.2	
	Any PIV	–	–	–	37.5/28.6/44.4	1190/804/1597	0.6/0.4/0.8	2.9/2.0/3.8	3429/1808/3528	1.7/0.9/1.8	
6–11 mo	PIV-1	1.2/0.0/2.4	365/0/747	0.2/0.0/0.4	14.3/0.0/25	444/0/934	0.2/0.0/0.5	2.1/1.9/2.2	427/377/462	0.2/0.2/0.2	
	PIV-2	0.6/1.1/0.0	182/327/0	0.1/0.2/0.0	17.9/41.7/0.0	555/1067/0	0.3/0.5/0.0	2.1/1.9/2.2	427/377/462	0.2/0.2/0.2	
	PIV-3	2.4/3.4/1.2	730/1012/374	0.4/0.5/0.2	7.1/16.7/0.0	220/427/0	0.1/0.2/0.0	4.1/3.8/4.4	835/753/923	0.4/0.4/0.5	
	Any PIV	4.1/4.6/3.6	1247/1369/1121	0.6/0.7/0.6	39.3/58.3/25	1219/1492/934	0.6/0.8/0.5	8.2/7.7/8.9	1669/1526/1867	0.8/0.8/0.9	
1–2 yr	PIV-1	3.4/0.0/6.3	1321/0/2534	0.2/0.0/0.3	31.8/7.4/48.7	3214/575/6245	0.4/0.1/0.8	1.8/0.0/4.1	1212/0/2864	0.2/0.0/0.4	
	PIV-2	0.0/0.0/0.0	0/0/0	0.0/0.0/0.0	10.6/14.8/7.7	1071/1151/987	0.1/0.1/0.1	0.7/0.7/0.8	471/457/559	0.1/0.1/0.1	
	PIV-3	3.4/5.5/1.6	1321/2071/644	0.2/0.3/0.1	12.1/29.6/0.0	1223/2302/0	0.2/0.3/0.0	3.3/3.9/2.5	2223/2543/1746	0.3/0.3/0.2	
	Any PIV	6.8/5.5/7.9	2641/2071/3177	0.3/0.3/0.4	53/48.1/56.4	5356/3740/7232	0.7/0.5/0.9	6.2/4.6/8.3 [§]	4176/3000/5797	0.5/0.4/0.7	
3–4 yr	PIV-1	0.0/0.0/0.0	0/0/0	0.0/0.0/0.0	37.5/0.0/100	716/0/2335	0.1/0.0/0.3	3.4/3.1/3.7	912/804/1030	0.1/0.1/0.1	
	PIV-2	0.0/0.0/0.0	0/0/0	0.0/0.0/0.0	0.0/0.0/0.0	0/0/0	0.0/0.0/0.0	0.0/0.0/0.0	0/0/0	0.0/0.0/0.0	
	PIV-3	0.0/0.0/0.0	0/0/0	0.0/0.0/0.0	0.0/0.0/0.0	0/0/0	0.0/0.0/0.0	0.0/0.0/0.0	0/0/0	0.0/0.0/0.0	
	Any PIV	0.0/0.0/0.0	0/0/0	0.0/0.0/0.0	37.5/0.0/100	716/0/2335	0.1/0.0/0.3	3.4/3.1/3.7	912/804/1030	0.1/0.1/0.1	
Total 0–4 yr	PIV-1	–	1685/0/3281	0.1/0.0/0.2	–	4969/575/10711	0.3/0.0/0.5	–	3379/1452/5284	0.2/0.1/0.3	
	PIV-2	–	182/327/0	0.0/0.0/0.0	–	2223/3022/1386	0.1/0.2/0.1	–	1135/833/1299	0.1/0.0/0.1	
	PIV-3	–	2050/3083/1017	0.1/0.2/0.1	–	1443/2729/0	0.1/0.1/0.0	–	5540/4833/4990	0.3/0.2/0.3	
	Any PIV	–	3888/3441/4298	0.2/0.2/0.2	–	8481/6037/12 097	0.4/0.3/0.6	–	10 186/7138/12 222	0.5/0.4/0.6	

Abbreviations: NVSN, New Vaccine Surveillance Network; PIV, parainfluenza virus. ^{*}Percentage of PIV-positive specimens tested in NVSN.

[†]Estimated number of annual PIV-associated hospitalizations.

[‡]Hospitalizations per 1000 US children.

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The percentages for „any PIV‐, include a single, odd-year PIV-4 detection in a 1- to <3-year-old.
§

Table 3

Hospitalization Charges and Lengths of Stay for Bronchiolitis, Croup, and Pneumonia Among All Hospitalizations and Those Associated With PIV From 1998 to 2010 According to HCUP

	Bronchiolitis	Croup	Pneumonia
Charges (USD)			
Per hospitalization, median (Q_1 – Q_3)	6997 (4345–11 780)	4517 (2847–7501)	7382 (4522–3239)
Average yearly total *			
All hospitalizations	1 086 821 000	121 221 000	3 120 193 000
PIV-associated hospitalizations	42 877 000	57 616 000	157 942 000
Length of Stay (days)			
Per hospitalization, median (Q_1 – Q_3)	2 (2–3)	1 (1–2)	2 (2–4)
Average yearly total *			
All hospitalizations	289 000	32 000	732 000
PIV-associated hospitalizations	11 000	15 000	36 000

Abbreviations: HCUP, Healthcare Cost and Utilization Project; PIV, parainfluenza virus; NVSN, New Vaccine Surveillance Network; USD, US dollars.

* Rounded to the nearest thousand.